

REMARKS

Applicants have carefully reviewed the Office Action outstanding in this application, and in response thereto have cancelled claims 12-15, 20, 23 and 24, have rewritten claims 16-19, 21 and 22, and have added new claims 25-40. Reconsideration of the application in light of these changes and in view of the following comments is respectfully solicited.

This invention is directed to multilevel three-dimensional structures, which may include photonic crystals, optical couplers or the like, of arbitrary shape fabricated in layers on the surface of a substrate, with each layer being a lithographically definable material and with adjacent layers preferably being separated by photosensitive barrier layers or films. The shapes of the layers are lithographically defined and exposed individually as the layers are formed. After all layers have been deposited on the substrate, all are developed in a single step to produce the final solid structure. This final structure has a shape corresponding to the shapes of the stacked layers, with each layer producing a corresponding level of the final structure.

The structure of the invention may be defined and formed on a substrate integrally with semiconductor devices also on the substrate to produce a monolithic device such as an optical coupler for interconnecting the semiconductor devices on the substrate with each other or with external optical devices. The lithographically defined layers may be a polymer or a positive or negative photoresist material so that, for example, the monolithic device of the invention may be formed from the exposed portions of the layers of a negative photosensitive material or from the

unexposed portions of a positive photosensitive material to produce a three-dimensional optical structure having multiple vertically aligned levels, each of arbitrary shape, and at any desired location on the substrate.

In the Office Action, claims 10-12 were objected to because of certain informalities. Claims 10 and 11 have been amended as suggested to overcome this objection. No informalities were pointed out with respect to claim 12, so it is not clear what the objections to that claim might have been. However, claim 12 has been rewritten as new claim 25; hopefully, any informalities have been corrected.

Claim 12 was rejected under 35 U.S.C. 112 as being incomplete. The rewriting of claim 12 is believed to have corrected this problem.

Claims 10-19 have been rejected under 35 U.S.C. 102(e) as anticipated by Matsuura et al, with particular reference to Figs. 24-28 of the document.

The reference to Matsuura et al. is directed to a method of producing a periodic laminate structure prepared by laminating photosensitive material layers with intermediate non-photosensitive layers. As taught in the patent, a first photosensitive layer 31a is formed on a substrate 30 and is exposed to provide a patterned layer. A non-photosensitive layer 33a is coated on top of layer 31a, and then a second photosensitive layer 31b is formed and patterned. This process is repeated to form the desired laminated structure. The photosensitive layers are then developed, and etching steps are performed on each non-photosensitive layer (see paragraph 99) to form the final device. In this process, openings, or voids, must be formed by etching top layers to allow subsequent development and etching of lower layers, producing a structure that is not solid, and that is, therefore, distinct from the structure of the present invention.

Claim 10, as now amended, distinguishes over Matsuura in the recitation of a

conducting polymer as one of the lithographically defined layers. There is no suggestion of such a feature in the reference. Claim 11 is dependant on claim 10, and further defines over Matsuura in reciting a photosensitive barrier layer. The barrier described in the reference is specified as being a non-photosensitive layer, and thus the reference cannot anticipate the invention defined in claims 10 and 11.

Claim 12 has been rewritten as new claim 25, and is now believed clearly to define over the reference to Matsuura. As now defined, the device of the invention is a solid, three-dimensional monolithic optical structure having multiple levels formed by corresponding layers of lithographically definable material. Each layer is of arbitrary shape, and the layers are vertically aligned and stacked to produce a solid structure having levels corresponding to the exposure patterns of each layer. In the present structure, each layer is patterned before the next layer is applied, so the resulting multilevel structure can be of arbitrary shape. The barrier layer of the present structure does not require the layers to be shaped in such a way as to allow etching of lower levels through openings provided in upper layers. The structural features of the several layers specified in the claims are not taught by the patent relied upon in the Office Action, resulting in fundamentally different structures. Accordingly, the claim is not anticipated by the Matsuura patent.

Claims 16-19 are dependent on claim 25 add features that further distinguish over the cited patent to Matsuura, claims 16-18 reciting positive or negative resist materials or combinations of these, and claim 19 reciting a photosensitive barrier layer. Claims 21 and 22 are dependant on claim 19, and further distinguish over the patent by defining different arbitrary shapes for each layer in claim 21 and defining optical transparency in claim 22. These claims are not anticipated by the cited

patent.

New independent claim 26 and the newly submitted claims 27-39 dependant thereon distinguish over the Matsuura patent for the reasons discussed above. Claim 26 defines a monolithic device having the same general features as recited in claim 25, and defines over the reference for the reasons already discussed.

Claim 27 defines the layers as being of arbitrary thickness, a feature that allows structures not contemplated by the Matsuura patent. Claim 28 defines non-periodic levels in the final structure, another feature not taught by Matsuura.

Claim 29 defines an optical coupler, a structure not found in the cited patent to Matsuura.

Claims 30-32 are dependant on claim 26, and further define the characteristics of the lithographically definable material, while claims 33-37 are also dependant on claim 26, and further define over the patent to Matsuura.

Claims 38 and 39 are dependant on claim 26, and define the barrier layer as being photosensitive, a requirement that is opposed to the teachings of Matsuura. Accordingly, claim 26 and the claims dependant on it are clearly patentable.

New independent claim 40 is directed to a photonic crystal structure having first and second adjacent, lithographically defined layers that are periodic in a direction parallel to each other. There is no teaching of such a feature in Matsuura, and accordingly the claim is clearly patentable.

In the Office Action, claims 10, 12 and 21 were rejected under 35 U.S.C. 102 over Chang et al. Claim 10 has been amended, claim 12 has been rewritten as new claim 25, and claim 21 is now dependent on new claim 25.

The patent to Chang et al. is directed to a process of fabricating a mask which

may be used to produce an etched recess having sloping walls. As described at Col. 7 of the patent, after resist mask 112 is formed, the underlying metal film 102 is etched. Then, as described at Col. 8, line 22, the resist mask 112 is removed, as by a solvent.

It is clear from the foregoing that the Chang "structures" referred to in the Office Action simply define a resist mask that is removed from the underlying layer, and the actual structure taught by Chang is the shaped metal film 102. Therefore, the Chang device cannot form the claimed optical coupler, and Chang cannot anticipate the invention set out in new claim 25. Claim 10 has been amended to define a conducting polymer and defines over the reference. Similarly, Chang cannot anticipate the newly-presented claims 26-39 which define a three-dimensional structure rather than a tapered edge on a metal film.

Claims 20 and 23 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Matsuura et al. in view of Yoshimura et al., it being said that Yoshimura teaches patterning photosensitive layers to form an optical coupler. However, claims 20 and 23 have been cancelled.

As discussed above, Matsuura does not teach the features of claim 10 or new claims 25, 26 or 40. Further, the Office Action does not assert that Yoshimura teaches anything more than the use of photosensitive material as a grating, and therefore this reference does not teach the features of any of the independent claims now in the application. Accordingly, even if it is assumed that the Yoshimura teaching can be combined with those of Matsuura, so that the Matsuura device becomes a wave guide, the resulting structure would not meet the terms of the claimed invention.

Claim 22 was rejected under 35 U.S.C. 103 as unpatentable over Matsuura in

view of Richardson, it being said that Richardson teaches that a photoresist layer can be optically transparent.

Claim 22 is dependant on claim 25, and since Richardson does not cure the deficiencies of Matsuura as discussed above, the combination of the references cannot meet the terms of either claim 25 or claim 22.

Claim 24 has been rejected under 35 U.S.C. 103(a) as unpatentable over Matsuura in view of Tran et al. It is asserted that Tran is "analogous art" that teaches formation of an optical component layer on an optical chip substrate, and that such teachings could be used to convert the Matsuura device into the claimed invention.

Although claim 24 has been cancelled, its features are incorporated into new claim 25. The assertion that Tran suggests converting the photosensitive layers of Matsuura into the photoresist layer of Tran to provide a monolithic optical component is not supported by the teaching of either reference, but is merely a combination of convenience created in response to applicant's claims. The Matsuura device does not teach applicant's structure, as discussed above, and the Office Action does not assert that Tran teaches that structure. Accordingly, the combination of the two references cannot provide a teaching that is missing from both. Accordingly, claim 25, as well as the other independent claims, is clearly patentable over the references, and so favorable reconsideration is respectfully requested.

CONCLUSION

In view of the foregoing amendments and remarks, the present application is now believed to be in condition for allowance. The Examiner is asked to consider entering this response and amendment and pass the application to allowance.

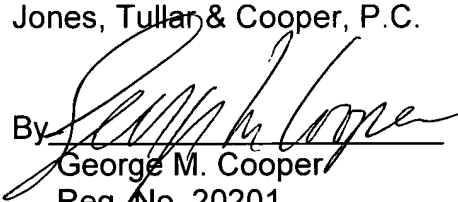
Further and favorable consideration is requested.

It is believed that a two month extension of time and fee is required.

However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims or the additional of independent claims in excess of three) is hereby authorized to be charged to Deposit Account No. 10-1213 and the undersigned is requested to be notified of any such charges.

Should the Examiner have any questions, he is requested to contact the undersigned.

Respectfully submitted,
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May 4, 2005
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